CHEMICAL & ENGINEERING NEWS

C&EN

JULY 11, 1994

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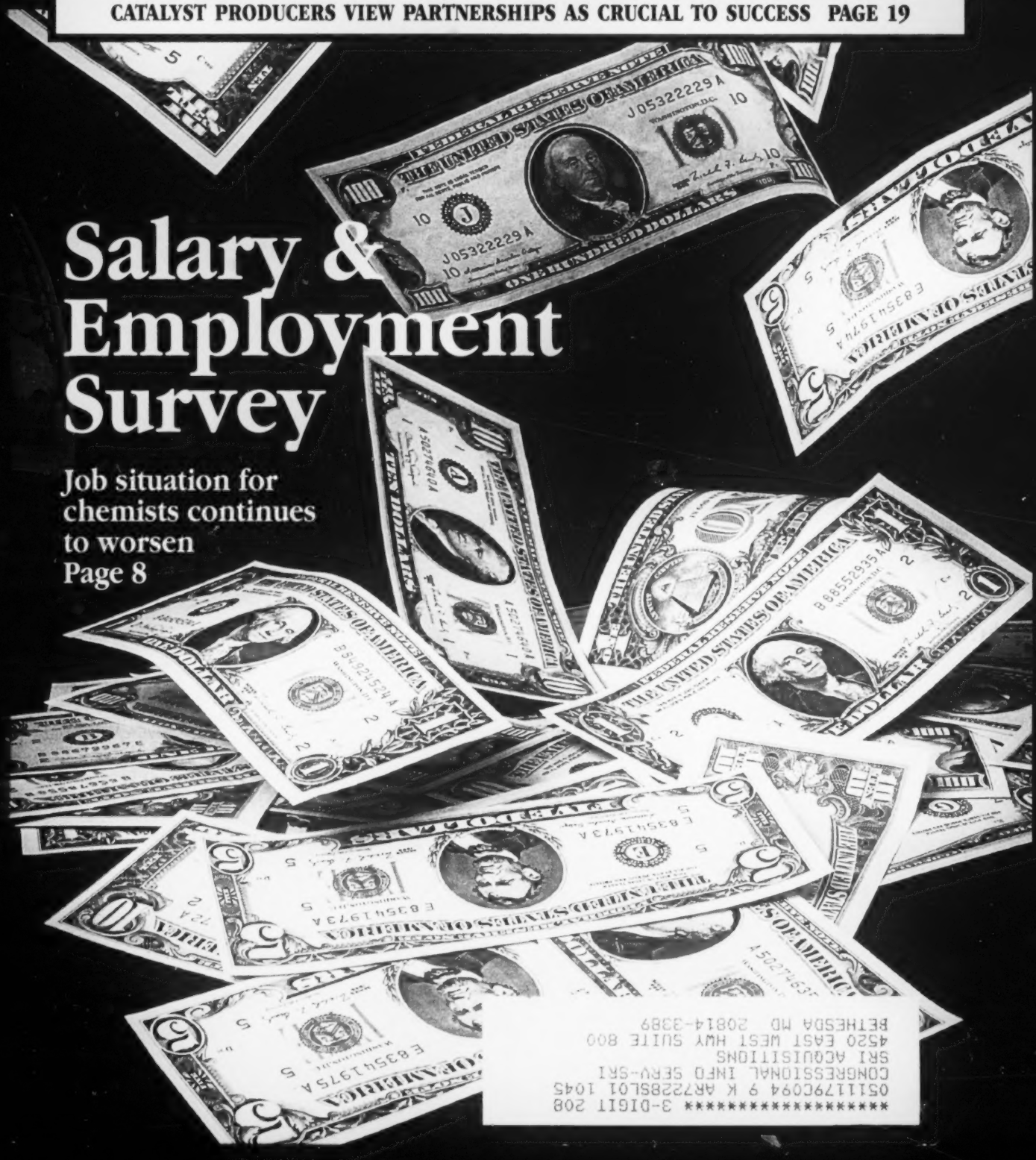
CATALYST PRODUCERS VIEW PARTNERSHIPS AS CRUCIAL TO SUCCESS PAGE 19

Salary & Employment Survey

Job situation for chemists continues to worsen Page 8



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CHEMICAL & ENGINEERING NEWS

C&EN

JULY 11, 1994

NEWS OF THE WEEK

■ EPA mandate that 30% of oxygenates used in reformulated gasoline must come from renewable sources fuels heated debate. **Page 4**

■ Panel of Michigan scientists finds insufficient evidence to phase out chlorine and chlorine-containing compounds as industrial feedstocks as proposed by a U.S.-Canadian group. **Page 5**

■ Elevated levels of organolead compounds in vintage French wine indicate the history of leaded gasoline use over the past 40 years. **Page 5**

■ New uses for catalytic antibodies in organic synthesis include peptide bond formation and thermodynamically disfavored eliminations. **Page 6**

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COVER: Photo by Henryk T. Kaiser/Uniphoto Picture Agency

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BUSINESS

Catalyst industry sees partnerships with customers and end users as means of survival and success in a sector pressured into change and growth by regulation. **Page 19**

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Working late, House approves appropriations bills calling for an overall 2% cut in R&D spending for fiscal 1995 with modest increases for NIH and NSF and a big boost for NIST. **Page 24**

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U.S. and Russia sign agreements boosting collaboration in areas such as basic sciences and engineering, space, biomedical research, environmental protection, and energy. **Page 30**

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SALARY SURVEY

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Chemical & Engineering News
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AMERICAN CHEMICAL SOCIETY
(202) 872-4600; TDD (202) 872-4432
John Kistler Crum, Executive Director
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Subscription Rates 1994: Printed editions: nonmembers U.S. 1 yr. $115, 2 yr. $207; outside U.S. 1 yr. $152, 2 yr. $281. Air freight rates available on request. Rates above do not apply to nonmember subscribers in Japan, who must enter subscription orders with Maruzen Co. Ltd., 3–10 Nihonbashi 2-chome, Chuo-ku, Tokyo 103, Japan. Tel: (03) 272-7211. Single copies: Current $18. Rates for back issues and volumes are available from Microforms & Back Issues Office, ACS, 1155—16th St., N.W., Washington, D.C. 20036. Back and current issues available on microfilm and microfiche. Rates on request from Microform Program, ACS.

Chemical & Engineering News (ISSN 0009-2347) is published weekly except for the last week in December by the American Chemical Society at 1155—16th St., N.W., Washington, D.C. 20036. Second-class postage paid at Washington, D.C., and additional mailing offices. POSTMASTER: Send address changes to C&EN, Member & Subscriber Services, P.O. Box 3337, Columbus, Ohio 43210. ACS assumes no responsibility for the statements and opinions advanced by the contributors to its publications.

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LETTERS

Plutonium vitrification

Congratulations to C&EN and Bette Hileman for the excellent article on plutonium (C&EN, June 13, page 12). The history and primary issues were reported thoroughly and clearly. I hope the article elevates the level and quality of debate on the subject. To that end, I have a few comments, which are my own, and do not necessarily represent the views of the Department of Energy or the Westinghouse Savannah River Co., for whom I am a senior advisory scientist.

The most urgent need, as the article pointed out, is to stabilize and secure the surplus plutonium in Russia, including plutonium from dismantled weapons and other forms of plutonium. To achieve that, it appears three things will be required. First, the U.S. must take similar action, although theft and diversion are less likely in the U.S. Second, the plutonium must be put in a form that is chemically stable and monitorable (accountable), and then secured via an internationally approved program of security, accountability, and inspection. Since permanent disposal is not acceptable to Russia (nor to most other nations), their storage form must permit recovery for plutonium for subsequent use as fuel. Third, the storage form should be such that it would take the host country a number of months to produce a weapon from the plutonium, thus giving the international community time to react.

Stabilizing surplus plutonium as borosilicate glass (without added fission products) may be the fastest and surest way to achieve these objectives. This form of plutonium, under an approved International Atomic Energy Agency or bilateral safeguards program (guards, fences, intrusion detectors, accountability, and inspections), would give a very high level of assurance that the plutonium could not be diverted quickly to weapons. This case was presented in the Westinghouse Savannah River Report ("Vitrification of Excess Plutonium," Westinghouse Savannah River Co., WSRC-RP-93-775, May 1993, Savannah River Site, Aiken, S.C.) on vitrification options that was input to the National Academy of Sciences (NAS) study and report ("Management and Disposition of Excess Weapons Plutonium," National Academy of Sciences, National Academy Press, Washington, D.C., 1994). Several unresolved technical issues with plutonium vitrification were identified in the article; however, these are normal process development items, not "showstoppers."

The article noted that the fuel value of plutonium is a central issue with wide disagreement. These disagreements exist, in part, because of the great complexity of analyzing the net cost and benefit of using plutonium as fuel. These analyses necessarily include many undefined variables and assumptions that require subjective judgments. However, it is important to note that nearly all the world's nations that have a modern nuclear power industry expect to use plutonium eventually in some kind of power-generating reactor. Indeed, essentially all experts agree that, eventually, plutonium will be a cost-competitive fuel for production of electricity. The disagreements are on when that time will come. The Japanese, French, and Russians (and perhaps others) believe that that time is imminent.

Unfortunately, objective debate is clouded by those who believe that all plutonium should be banished from Earth, regardless of its potential value as an energy source, because of its possible use in nuclear weapons. It is quite clear that the cornerstone of the world's nuclear nonproliferation program will be international control of and accountability for the very large and growing inventory of fissile material that is being beneficially used to produce much-needed clean energy throughout the world. It is not beneficial to this very important nonproliferation effort for any one nation to unilaterally refrain from producing, and beneficially using, this resource.

The two principal recommendations in the NAS report are long-term options requiring major capital projects. Some aspects of each of those approaches are in dispute among nuclear experts. It may not be possible to put such material in a geologic repository because of criticality safety concerns and international safeguard requirements. Even if it were possible, it may not be wise because it would waste a future, clean, valuable energy source that would enhance U.S. efforts toward greater energy independence, and it would create a convenient plutonium mine when the fission products decayed to low levels, thus requiring international safeguards of the repository in perpetuity.

There are also some issues with the oth-

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Job Market For Chemists Weakest In More Than 20 Years, Salary Gains Dip

Annual ACS survey of members shows a further big surge in the growth in unemployment that has been under way since 1990

Michael Heylin, C&EN Washington

It is hard to find many positive signs in the masses of data collected for the American Chemical Society's latest annual employment and salary survey of its members.

Survey results indicate that the employment situation is the worst it has been since the early 1970s, a notoriously bad time for the chemical community. Year-to-year gains in basic salaries are down. And bonuses and other additional professional income are actually smaller than they were last year.

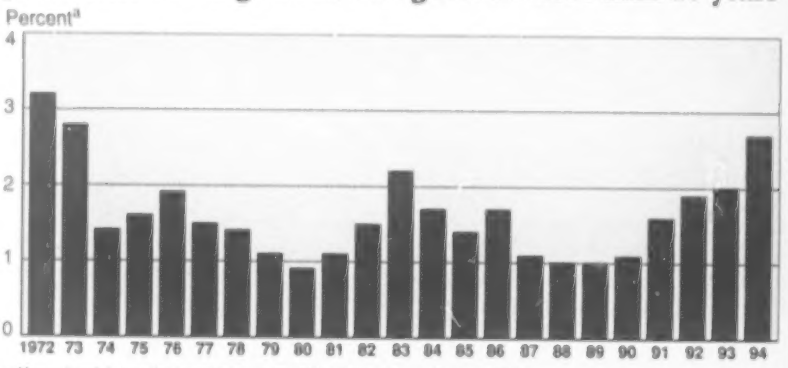
Unemployment among chemists is at 2.7%, up from 2.0% one year earlier and from 1.1% as recently as 1990. Individual chemists' salaries show a mean 12-month gain of 4.7%. This shows slippage from the mean 5.2% gain posted the previous year.

As in recent years, the survey was directed by statistician and senior research analyst Joan S. Burrelli of ACS's Office of Professional Services.

The data indicate that much of the softness in both employment and pay is found in industry. Terminations, early retirements, and golden-handshake separations are still thinning the ranks of chemists working in industry, especially older ones. And the little hiring that is being done is apparently mostly of younger, lower paid replacements.

The survey is based on 9,788 responses to questionnaires mailed to 20,000 ACS members. Those polled all live in the U.S. and are not more than 70 years old. They are neither students nor retirees. The data gathered are as of March 1, as they are for previous surveys. About 1,000 of the responses this year are from chemical engineers and others who do not have chemistry as their highest degree. Virtually all the employment and salary data presented in this article are for chemists only.

Joblessness among chemists highest in more than 20 years



a Unemployed, but seeking employment, as of March 1 each year. **Source:** ACS survey

Younger chemists post largest salary gains

Mean salary increase[a]	By degree B.S.	M.S.	Ph.D.
BY EMPLOYMENT			
Industry	5.3%	5.1%	4.6%
Government	4.1	4.4	4.2
Academia	4.8	3.4	4.2
TOTAL	5.2%	4.9%	4.5%
BY AGE			
20–29	6.8%	6.2%	4.9%
30–39	6.0	5.9	5.5
40–49	4.2	5.0	4.6
50–59	3.6	4.0	3.8
60–69	4.2	2.9	2.9
TOTAL	5.2%	4.9%	4.5%

a Mean salary increase for individual chemists between March 1, 1993, and March 1, 1994. **Source:** ACS survey

Chemists' unemployment apparently mainly due to cutbacks by industry

	Employed[a] Full time	Part time	Postdoc	Seeking employment
EMPLOYER				
Industry	95.3%	1.3%	0.4%	3.1%
Academia	86.1	3.5	9.0	1.5
Government	92.6	1.5	5.2	0.8
Other nonacademic	78.3	14.1	2.3	5.3
MOST RECENT WORK				
Production	95.3	0.9	0.0	3.8
R&D management	96.4	1.1	0.0	2.6
General management	95.7	2.1	0.0	2.1
Marketing	93.6	2.3	0.0	4.1
R&D	89.6	1.2	7.0	2.2

Note: Some totals do not add to 100.0% because of rounding. a As of March 1, 1994. **Source:** ACS survey

Total of chemists unemployed, on postdocs, or with part-time jobs at unusually high level

Employment status[a]	Chemists								Chemical engineers
	Total	By sex		By highest degree			By minority status		
		Men	Women	B.S.	M.S.	Ph.D.	Minority[b]	Nonminority	
Employed full time	90.1%	90.5%	88.3%	91.5%	90.7%	89.3%	85.9%	90.7%	91.7%
Employed part time	2.5	2.0	4.3	2.5	3.4	2.2	1.4	2.6	2.3
Postdoctoral or fellowship	2.9	3.1	2.2	0.2	0.3	4.7	7.8	2.1	0.4
Unemployed									
Seeking employment	2.6	2.6	2.6	3.0	3.0	2.3	3.6	2.5	3.1
Not seeking employment	2.0	1.8	2.5	2.8	2.5	1.5	1.3	2.0	2.5

Note: Some totals do not add because of rounding. **a** As of March 1, 1994. **b** Black, Spanish/Hispanic, Native American, Alaskan native, Asian, Pacific Islander, or other. **Source:** ACS survey

Percentage of chemists employed full time dips for the sixth year in a row

Employment status[a]	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Employed full time	93.7%	95.2%	94.8%	95.4%	95.4%	95.3%	95.2%	94.0%	93.4%	92.8%	91.9%
Employed part time	1.7	1.5	1.5	1.5	1.6	1.5	1.4	1.8	2.2	2.2	2.5
Postdoctoral or fellowship	2.9	1.9	2.0	2.0	2.0	2.2	2.2	2.6	2.4	3.0	2.9
Unemployed	1.7	1.4	1.7	1.1	1.0	1.0	1.1	1.6	1.9	2.0	2.7

Note: Some totals do not add because of rounding. **a** As of March 1, 1994; excludes chemists who are not employed but not seeking employment. **Source:** ACS survey

Of all respondents, 23.9% have a B.S. as their highest degree, 18.7% an M.S., and 57.4% a Ph.D. By gender, 19.6% are women. By race, 86.3% are white, 8.9% Asian, 1.9% Hispanic, 1.6% black, 0.5% American Indian, and 0.8% "other." By place of employment, 62.8% work for industry, 22.6% are in academia, 7.7% work for governments, and 7.0% are employed elsewhere.

The 2.7% unemployment rate from the new survey is the percentage of chemists in the labor force who were jobless, but seeking employment, as of March 1. An additional 2.0% of those who responded to the survey indicated they were unemployed but not seeking employment.

This basic measure of joblessness among chemists in the labor force fluctuates within a relatively narrow range. But it is an extremely sensitive indicator of the employment status of the chemical profession.

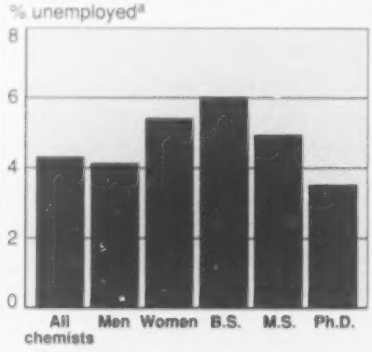
Results from the ACS surveys over the years indicate that in good times for the chemical industry and profession—such as 1979 through 1981 and 1987 through 1990—the number of chemists unemployed but seeking employment hovers very close to 1.0%. If it moves up toward 2.0%, as it did in 1992 and 1993, it indicates a sharply weakening job market, with reduced employment opportunities for younger chemists and decreased job security for those with jobs, especially in the industrial sector.

This year's figure of 2.7% reflects clearly today's especially tough employment situation. It well exceeds the recent high of 2.2% in 1983. At the height of the economic troubles of the early 1970s, this measure of joblessness among chemists peaked at 3.2% in 1972.

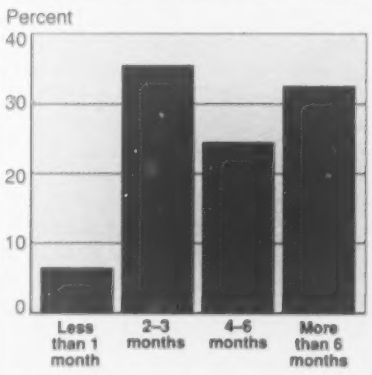
A broader indicator of the job situation for chemists is the sum of those out of work but looking for it, those on postdocs, and those employed part time. In good times this total is about 4.5%, with 1% unemployed, 2% on postdocs, and 1.5% employed part time. In 1993, this total moved up to 7.2%. This year, it is at 8.1%. This is by far the highest on record, with 2.7% unemployed, 2.9% on postdocs, and 2.5% employed part time. In 1983, this total was 6.5%. Exactly comparable figures are not available for 1972; in those days, the analysis of employment was done a little differently and included a "subprofessionally employed" category.

The poor employment situation for chemists permeates all segments of the work force. Doctoral chemists are slightly less likely to be actually unemployed. However, last year they were also less likely to be employed full time, as an unusually high 4.8% of them were in postdoc positions. By gender, more women, 4.4%, were employed part time last year. This com-

Over 4% of chemists were jobless sometime in 1993...

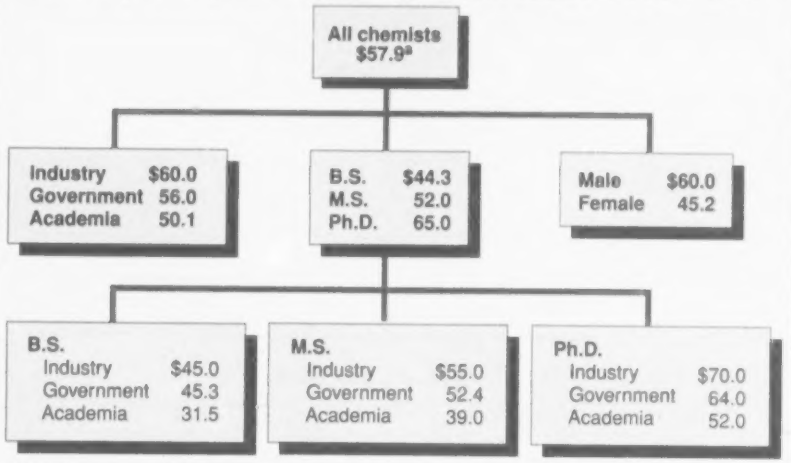


...with a third of these out for six months or more



a Unemployed at sometime in 1993.
Source: ACS survey

Industry salary advantage is greatest for Ph.D. chemists



a Median base annual salaries in thousands of dollars as of March 1, 1994. **Source:** ACS survey

pares with 2.1% for men. This difference, however, is usual. Minority chemists are the least likely to be employed full time. But a high percentage of them, 7.9%, are postdocs. By age, chemists between 50 and 59 are the most likely to be jobless but looking for work. Of respondents to the last survey, 3.5% of them were in this position.

Another indicator of the weak job market is the number of chemists, 4.3%, who were unemployed at some time during 1993. For 1992 the corresponding number was 4.0%. By degree, the 1993 rate ranges from 6.0% for B.S. chemists to 3.5% for Ph.D.s. Of those unemployed during last year, almost one third were jobless for more than six months. This is up from one fourth a year earlier.

The role of industry in the high unem-

Median salaries for bachelor and master chemists showed only weak gains in 1993

$ Thousands	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	% annual change 1993–94	1989–94	1984–94
CHEMISTS' MEDIAN SALARIES[a]														
B.S.	$30.9	$32.0	$33.0	$33.5	$35.4	$37.0	$39.0	$40.3	$42.0	$43.5	$44.3	1.8%	3.7%	3.7%
M.S.	34.0	36.0	37.9	39.0	41.0	43.0	45.0	47.4	50.0	51.5	52.0	1.0	3.9	4.3
Ph.D.	42.0	44.0	47.8	47.7	50.0	52.5	55.0	58.0	60.0	62.8	65.0	3.5	4.4	4.5
All chemists	38.0	40.0	42.5	42.5	45.0	47.3	49.8	52.0	54.6	56.0	57.9	3.4	4.1	4.3

a Base annual salary of chemists employed full time as of March 1, 1994. **Source:** ACS survey

Top 10% of older industrial Ph.D. chemists earn $100,000 or more, lowest 10%, $60,000

Median salary, $ thousands[a]	Years since B.S. degree									
	2 to 4	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 or more	Overall
INDUSTRIAL CHEMISTS										
B.S.										
90%	$41.0	$50.0	$60.0	$70.0	$ 85.0	$ 80.0	$ 95.0	$ 97.5	—	$ 72.0
75%	36.0	44.5	52.0	60.2	70.0	70.5	80.4	75.0	—	58.0
50%	31.5	39.0	45.0	51.0	58.0	59.6	64.6	65.2	—	45.0
25%	27.8	33.0	39.0	42.8	49.0	50.0	50.0	50.8	—	35.7
10%	23.2	28.5	33.0	36.0	40.8	39.8	41.0	37.5	—	29.2
M.S.										
90%	—	55.0	68.0	76.0	80.5	84.7	104.8	100.0	—	80.7
75%	—	48.0	56.0	65.0	67.0	74.0	88.0	85.0	—	67.0
50%	—	43.0	49.0	55.7	59.7	63.3	68.0	66.3	—	55.0
25%	—	37.7	43.0	48.0	50.0	51.0	56.1	56.7	—	46.0
10%	—	33.0	38.6	42.5	42.0	43.1	49.5	47.4	—	39.0
Ph.D.										
90%	—	63.0	72.0	89.0	100.0	113.0	130.0	118.0	135.0	104.6
75%	—	60.0	65.0	77.9	88.0	96.4	105.0	100.3	109.3	85.2
50%	—	55.0	60.0	68.1	74.0	80.2	85.0	85.6	88.0	70.0
25%	—	52.0	55.0	61.0	66.0	69.3	73.1	71.5	73.0	60.0
10%	—	45.0	50.0	54.0	57.6	59.6	61.0	60.0	57.1	52.5

How to read this table: Using, as an example, industrial B.S. chemists two to four years after they have received their B.S. degree, 90% of these chemists have annual base salaries of $41,000 or less; 75% have annual base salaries of $36,000 or less, 50% have annual base salaries of $31,500 or less, 25% have annual base salaries of $27,800 or less, and 10% have annual base salaries of $23,200 or less, as of March 1, 1994. **Note:** Where no salary data are shown, sample is too small to provide meaningful figure. a As of March 1, 1994. **Source:** ACS survey

Women's salaries about 10% below men's, even after length of service adjustment

Mean salary, $ thousands[a]	B.S. All chemists	B.S. Men	B.S. Women	B.S. Women as % of men	M.S. All chemists	M.S. Men	M.S. Women	M.S. Women as % of men	Ph.D. All chemists	Ph.D. Men	Ph.D. Women	Ph.D. Women as % of men
EMPLOYER												
Industry	$49.3	$52.3	$46.6	89%	$58.5	$60.6	$54.6	90%	$75.9	$77.6	$66.3	85%
Academia	32.3	34.4	30.9	90	41.7	44.3	39.5	89	56.7	58.9	51.0	87
Government	46.1	47.5	47.1	99	52.9	54.3	52.2	96	64.9	65.7	61.1	93

a As of March 1, 1994; to facilitate comparison, women's salaries are adjusted for the difference in average length of experience between women and men. **Source:** ACS survey

ployment figures is reflected in data on the last place of employment of those without jobs. In the latest survey, 3.1% of those last employed by industry were jobless but seeking employment. This compares with 1.5% for academia and 0.8% for government. In the previous survey, this gap was not as wide, with 1.9% for industry, 1.6% for academia, and 1.5% for government.

The data in the latest survey on salaries are less bleak than those on employment. At least, there are some gains. (All salary data represent the base salaries of the principal job of chemists. Overtime, bonuses, fees from consulting, and other professionally related income are not included. These are analyzed separately.)

The median salary of all chemists responding to this year's survey is $57,900, up 3.4% up from the year-earlier median of $56,000. The median salary of a group is that which is equaled or exceeded by one half of the sample. This 3.4% growth compares with an average annual gain of 4.1% for the previous five years.

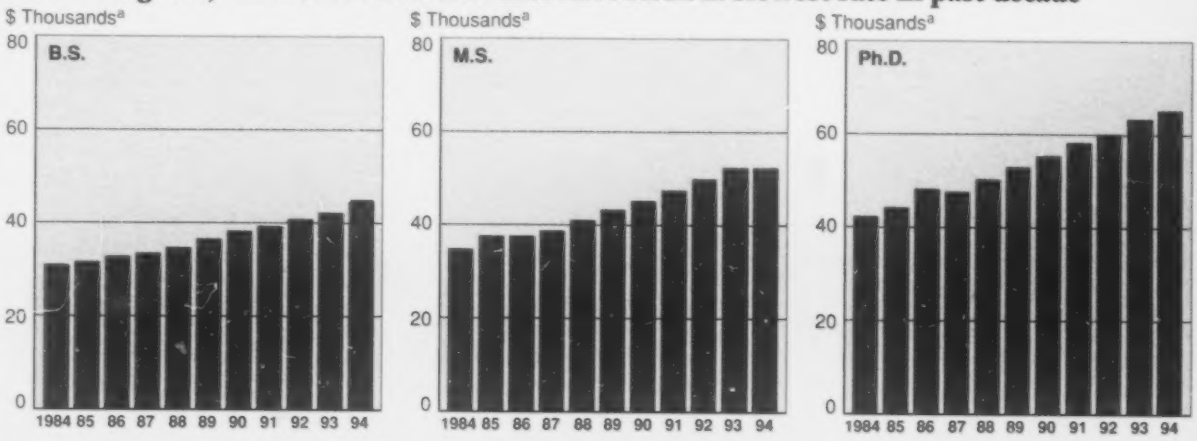
For the academic chemical work force as a group, the gain in salaries in

Keys to higher industry salaries: Get a Ph.D., be a manager, stay a long time

Median salary, $ thousands[a]		Years since B.S. degree: 2 to 4	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 or more	Overall
CHEMISTS EMPLOYED FULL TIME IN INDUSTRY											
Total											
B.S.		$31.5	$39.0	$45.0	$51.0	$58.0	$59.6	$ 64.6	$65.2	$ 68.0	$45.0
M.S.		—	43.0	49.0	55.7	59.7	63.3	68.0	66.3	62.0	55.0
Ph.D.		—	55.0	60.0	68.1	74.0	80.2	85.0	85.6	88.0	70.0
Sex											
Men	B.S.	31.5	40.0	45.9	52.0	58.9	60.0	66.8	67.2	69.3	48.6
	M.S.	—	43.0	49.0	55.7	60.0	65.0	72.2	68.0	64.5	56.8
	Ph.D	—	55.0	60.5	68.4	75.0	81.6	87.4	86.0	91.0	72.0
Women	B.S.	30.8	36.2	43.1	48.8	50.0	51.6	—	—	—	39.0
	M.S.	—	42.6	49.0	55.0	58.0	51.4	60.5	—	—	48.0
	Ph.D.	—	57.0	58.0	67.0	70.0	70.0	69.5	—	—	60.0
Work function											
General management	B.S.	—	46.0	42.7	55.5	61.4	—	66.0	—	—	52.9
	M.S.	—	—	—	59.0	66.5	—	—	—	—	68.6
	Ph.D.	—	—	—	—	84.0	84.3	113.5	—	—	85.3
R&D management	B.S.	—	46.5	—	—	78.0	—	85.0	—	—	63.0
	M.S.	—	—	—	72.0	64.7	70.0	78.7	85.8	—	70.5
	Ph.D.	—	—	65.4	79.0	88.0	93.4	100.3	95.0	109.3	88.0
Basic research	B.S.	32.6	39.0	44.8	—	—	—	—	—	—	41.0
	M.S.	—	41.0	49.4	—	—	—	—	—	—	49.8
	Ph.D	—	55.6	62.0	70.0	74.5	76.9	84.0	—	—	68.4
Applied research	B.S.	34.0	39.0	45.0	51.0	53.1	59.0	66.8	—	—	43.2
	M.S.	—	43.9	49.0	54.7	60.0	59.3	70.4	61.0	—	54.0
	Ph.D.	—	55.0	59.0	65.0	70.0	75.0	75.0	76.6	82.0	65.0
Production	B.S.	31.5	35.0	42.5	49.0	52.0	—	—	—	—	42.0
	M.S.	—	44.0	43.5	51.2	50.0	56.8	—	—	—	49.4
	Ph.D.	—	—	—	67.0	67.0	73.0	—	—	—	64.9
Marketing	B.S.	32.2	41.0	51.0	58.8	55.0	—	—	—	—	50.4
	M.S.	—	—	—	61.0	—	—	—	—	—	58.0
	Ph.D.	—	—	—	—	—	84.3	—	—	—	75.0

Note: Where no salary data are shown, sample is too small (less than 15) to provide meaningful figure. a As of March 1, 1994. **Source:** ACS survey

For all degrees, salaries for B.S. chemists have risen at slowest rate in past decade



Note: Average salary increases for individual chemists have been larger because of increasing experience. a Median base annual salary for chemists employed full time as of March 1 of each year. **Source:** ACS survey

the new survey is 1.6%; for those in government, it is 3.7%. However, for chemists in industry as a group there was no change. In both years, this median salary was $60,000.

Interpreting the differences in median salaries obtained from two surveys carried out one year apart has to be done with care, however. For instance, although the median salary for the entire sample of chemists employed in industry didn't change from the 1993 survey to the one in 1994, the medians for each of the major subgroups—those with B.S. degrees, with M.S. degrees, and with Ph.D.s—all rose. For the B.S. group, the gain was a mere 0.5%, for M.S. chemists it was 1.9%, and for Ph.D.s it was 1.6%. Analyst Burrelli explains that this sort of thing can happen when medians from different studies are compared.

In general, movements in the median salaries of large groups of employees reflect not only the actual changes in the salaries of individuals but also significant changes in the makeup of the population being analyzed. And there is no doubt that the work force of chemists in industry, as a group, is tending to become younger and lower paid.

The results of this year's survey reflect this trend. When asked to report their salaries as of both March 1, 1993, and March 1, 1994, industrial chemists employed on both these dates report a mean gain of 4.9%. This suggests that the lack of growth in the median salary for industrial chemists as a group over the past year is due primarily to a lowering of the experience level of this population with the separation of many older, better paid employees and the hiring of fewer and less experienced replacements.

ACS has been collecting data on the year-to-year salary increases of individual chemists for only two years. Both years show a similar pattern. The bigger percentage gains tend to come early in a career and then trail off. For instance, the mean gain this year for B.S. chemists aged between 20 and 29 and working for industry is 6.8%. For B.S.

Doctoral chemists earn about 50% more than their bachelor colleagues

Median salary, $ thousands[a]	Years since B.S. degree									Overall median
	2 to 4	5 to 9	10 to 14	15 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 or more	
ALL CHEMISTS	$31.5	$41.5	$51.0	$59.0	$64.0	$65.9	$68.0	$69.0	$71.5	$58.0
By sex										
Male	31.6	43.0	52.5	60.0	65.0	68.1	72.0	70.0	72.0	60.0
Female	30.5	39.0	45.9	53.0	52.1	55.0	54.0	52.0	55.6	45.4
By degree										
B.S.	31.0	38.0	44.0	51.0	54.0	58.2	56.0	64.1	65.0	44.4
M.S.	—	41.3	47.5	55.0	55.0	57.4	60.0	62.0	58.0	52.1
Ph.D.	—	52.8	56.0	63.3	69.0	72.0	73.0	72.0	75.0	65.0
By employer										
Industry	31.5	43.0	54.3	62.0	68.0	73.0	79.0	76.1	80.0	60.0
Government	—	37.2	47.4	58.0	53.5	62.0	65.4	59.0	71.0	56.0
Academia	—	31.0	37.5	42.3	43.5	55.0	56.3	60.0	63.0	50.1

a As of March 1, 1994. **Source:** ACS survey

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industrial chemists aged between 50 and 59, it is 3.6%. These mean individual increases reflect the growing experience and responsibilities of the people involved as well as any promotions they receive.

Information about professional income other than base salary shows a very skewed pattern. For instance, the new survey indicates a mean bonus for all respondents of $2,800, down from $2,900 in the previous year. However, the median is zero, as more than half received no bonus at all. Those in the upper 10 percentile had bonuses of $6,500 or more. Chemists working in industry are considerably more likely to receive bonuses than their colleagues in academia and government.

When overtime pay, consulting fees, and the like are included with bonuses, the mean of all extra professionally related income is $6,300, down from $7,800. More than 40% of respondents received nothing. The median is $1,200. Those in the top 10 percentile received $15,300 or more.

For the first time, this year's survey probes into the benefit plans and other fringe benefits chemists enjoy. At the top of the list, as reported by more than 90% of respondents, are holidays, annual leave, life insurance, and medical coverage for themselves and family. Less universal are sick leave (87%), dental coverage for themselves (85%), dental coverage for family (82%), accidental death insurance (77%), time off for jury duty (73%), a prescription drug program (71%), and long-term disability benefits (70%).

The latest survey indicates that the salaries of women chemists continue to creep closer to those of their male counterparts, but that progress is still a little spotty. For instance, after allowing for the generally greater professional experience of men, the mean salary of women B.S. chemists working for government is 99% that of corresponding men. At the other end of this spectrum, women Ph.D.s working for industry receive salaries only 85% that of their male counterparts. For all types of employers, women on average receive close to 90% the corresponding amount given to men.

According to the survey, women at all degree levels and within all major employment sectors—industry, academia, and government—made salary gains relative to men with one exception, women with doctorates working in industry.

A full report on this year's survey, "Salaries 1994," will be available in August at $150 per copy from the American Chemical Society, Distribution Office, 1155—16th St., N.W., Washington, D.C. 20036; phone (202) 872-4363. Questions about the survey should be directed to Burrelli at (202) 872-4433. □

Research, production garner lower salaries

Median salary, $ thousands[a]	By degree		
	B.S.	M.S.	Ph.D.
R&D management	$63.0	$70.5	$88.0
General management	52.7	68.3	85.5
Marketing	50.4	58.0	75.0
Applied research	43.2	54.0	65.0
Production	42.0	49.4	64.9
Basic research	41.0	49.7	68.3

a As of March 1, 1994. Source: ACS survey

Salaries of smallest firms lag by more than 10%

Median salary, $ thousands[a]	By degree		
	B.S.	M.S.	Ph.D.
NUMBER OF EMPLOYEES			
Less than 500	$40.0	$50.0	$66.0
500 to 2,499	44.8	53.0	69.0
2,500 to 9,999	48.6	55.0	70.0
10,000 to 24,999	51.5	60.0	72.0
25,000 or more	49.1	58.6	74.0

a As of March 1, 1994. Source: ACS survey

Big gap between Ph.D. and non-Ph.D. schools

Median salary, $ thousands[a]	9- to 10-month contracts		11- to 12-month contracts	
	Non-Ph.D. school	Ph.D. school	Non-Ph.D. school	Ph.D. school
Full professor	$52.0	$67.5	$76.5	$86.6
Associate professor	40.0	45.5	53.0	60.5
Assistant professor	33.6	40.8	44.3	46.8

a As of March 1, 1994. Source: ACS survey

House Votes To Cut Back Overall Federal R&D Funding In 1995

■ ***Appropriations for NIH, NSF, and NIST would rise, but total R&D funding would decline 2% to $77.9 billion***

Janice Long, C&EN Washington

By burning a little midnight oil the House managed to complete its work on all of the fiscal 1995 appropriations bills that provide research and development funding before members left Washington for the Fourth of July recess. Working within some very stringent 1995 budget caps, the House found it necessary to reduce overall funding for R&D agencies by 2% to $77.9 billion. The bills now go to the Senate, but there isn't much hope that it will be any more generous than the House where research funding is concerned. In many cases, the Senate is working under even lower budget caps than the House was.

Some bright spots do exist in the House version of the R&D budget. For instance, funding for the National Institute of Standards & Technology would rise 62% to $842 million, and the National Science Foundation's total budget would be up 12% to $3.1 billion. However, those increases are more than offset by a 10% decrease, to $5.1 billion, in the Department of Energy's energy R&D budget, and a 2% decrease, to $35.1 billion, for Department of Defense R&D programs.

The House took a mere 15 minutes, late on the night of June 29, to approve a budget of $244 billion for DOD in fiscal 1995, a 1% increase over current DOD funding. Within the R&D allotment, which accounts for just 14% of the total DOD budget, funding for the Ballistic Missile Defense Organization (formerly known as the Strategic Defensive Initiative or Star Wars) would decline 18% to $2.0 billion, while funding for basic research would increase 4% to $1.25 billion.

However, the budget, as reported out of the Appropriations Committee and approved by the House, cuts all support, $828 million, for two of the Administration's pet programs—the defense reinvestment project and the manufacturing technology program—run by the Advanced Research Projects Agency. Also cut in half is the $1.8 billion request for university research.

As Rep. George E. Brown Jr. (D.-Calif.), chairman of the Committee on Science, Space & Technology notes, these cuts are aimed at programs that provide direct support for advanced technology development at DOD. These include areas such as laser and optical sciences, materials science, applied mathematics, and computer science. The same fields are among the areas of emphasis laid out by President Clinton in his technology initiatives. In short, Brown said, "If these cuts stand, they will directly undermine DOD's science and technology strategy and the President's technology plan."

Furthermore, he points out, the university cut would severely damage academic research institutions that depend heavily on DOD support. Among the top 10 recipients of that support are the University of Texas, Massachusetts Institute of Technology, Johns Hopkins University, Georgia Institute of Technology, and Stanford University. Brown notes that "the silence on this cut is deafening. . . . We hear no howls and no rage." That, he believes, is because "All of use here in this body assume, and I think correctly, that this problem will go away in the Senate and in conference, and the money will be restored."

Some believe the defense appropriations subcommittee, chaired by Rep. John P. Murtha (D.-Pa.), took aim at university research because of an ongoing dispute with Brown over academic earmarks. Science committee staff have found at least $67 million in academic earmarks in the current DOD bill, according to Brown, and there are probably a lot more that haven't been detected yet. Those found so far include $18 million to the University of Pittsburgh for the National Defense Center of Environmental Excellence, $10 million for the San Diego State University Conversion Center, and $4 million for the University of New Orleans Advanced Marine Technology Center.

Preceding the DOD appropriations bill on the House's June 29 schedule, the Departments of Veterans Affairs and Housing & Urban Development, and Independent Agencies 1995 appropriations bill generated more debate—about seven hours worth—among House members. However, few changes were made to the bill, which funds the National Science Foundation, National Aeronautics & Space Administration, and the Environmental Protection Agency.

Under the bill, total NSF funding would rise substantially from 1994, with funding for research and related activities up 11% to $2.2 billion, versus the 18% increase sought by the Administration. The bill cuts in half the requested increase of $66 million for global-change research, leaving it with a still healthy 23% increase to $175 million. The bill also cuts $29 million from the $62 million increase requested for the high-performance computing and communication initiative, leaving it with a 12% increase to $300 million. The Appropriations Committee took these actions because of concerns that "these new initiatives are being funded at the expense of significant and ongoing research efforts." The bill also does not include the one-year freeze in the payment of indirect costs to academic institutions requested by the Administration.

During the debate on the VA-HUD bill, the House easily defeated, 278 to

Cuts in defense, energy research drag down '95 R&D budget

$ Millions	1994	1995 Administration request	1995 House appropriation	% difference, appropriation-request	% change 1994–95
Defense	$35,888	$35,962	$35,137	–2%	–2%
Development	26,327	26,652	26,303	–1	0
Operational systems	11,474	10,906	12,210	12	6
Engineering & manufacturing	7,441	8,916	7,758	–13	4
Advanced	4,669	3,846	3,248	–16	–30
Exploratory	2,743	2,984	3,087	3	13
Management & support	3,218	3,079	3,077	0	–4
Demonstration & validation	2,698	2,566	2,507	–2	–7
Ballistic Missile Defense Organization	2,440	2,440	2,002	–18	–18
Basic research	1,205	1,225	1,249	2	4
General reduction, university research	—	—	–1	na	na
NASA	15,113	14,284	14,044	–2	–7
Science, aeronautics & technology	5,788	5,901	5,901	0	2
Human space flight	6,672	5,720	5,593	–2	–16
Mission support	2,653	2,663	2,550	–4	–4
Energy	12,742	12,168	11,796	–3	–7
Environmental restoration & waste management	5,899	5,961	5,872	–1	0
Energy R&D	5,706	5,411	5,147	–5	–10
General science & research	1,615	1,110	989	–11	–39
Superconducting Super Collider termination costs[a]	640	180	0	na	na
Supporting research & technical analyses	976	956	943	–1	–3
Materials sciences[a]	277	274	277	1	0
Chemical sciences[a]	169	162	165	2	–2
Waste R&D	687	703	703	0	2
Conservation	385	588	482	–18	25
Biological & environmental research	416	435	435	0	4
Fossil	431	451	429	–5	0
Solar & renewables	347	398	402	1	16
Fusion	348	373	377	1	8
Nuclear	341	248	260	5	–24
Environment, safety & health	160	149	127	–15	–21
Weapons R&D	1,137	796	777	–2	–32
NIH	10,938	11,471	11,322	–1	4
National Institutes	10,001	10,433	10,302	–1	3
General Medical Sciences[a]	876	908	902	–1	3
National Center for Research Resources	332	351	358	2	8
National Center for Human Genome Research	127	152	152	0	20
Other	478	535	510	–5	7
NSF	2,796	3,199	3,141	–2	12
Research & related activities	1,993	2,348	2,217	–6	11
Education & human resources	570	586	586	0	3
Major research equipment	—[b]	70	105	150	na
Academic research infrastructure	105	55	100	82	–5
Other	128	140	133	–5	4
USDA	1,416	1,365	1,366	0	–4
Agricultural Research Service	728	743	717	–3	–2
Cooperative State Research Service	495	419	448	7	–9
Forest research	193	203	201	–1	4
Commerce	747	1,166	1,080	–8	45
National Institute of Standards & Technology	520	935	842	–10	62
Oceanic & atmospheric research	227	231	238	3	5
TOTAL	$79,640	$79,615	$77,886	–2%	–2%

a. Funds included in preceding total. b. Data not available. na = Not applicable.
Source: House Appropriations Committee reports

155, an amendment that sought to prohibit spending the $2.1 billion provided for the space station and instead direct the funding to other NASA programs. Last year, an attempt to eliminate the space station and use its funds for deficit reduction failed by only one vote. Overall, the bill provides NASA with $14.0 billion, a 7% decrease from current funding levels. It's hard to tell how much of that would fund R&D activities because NASA has changed its budget accounts and no longer has a category entitled R&D. This year 40% of the human space flight budget is going for R&D activities, as is 81% of the science, aeronautics, and technology budget, and 14% of the mission support budget.

EPA has also changed its budget accounts, mixing together the old R&D and abatement, control, and compliance accounts. For what it's worth, funding for the new account—research, prevention, and program activities—would fall 5% to $1.6 billion.

The appropriations bill that funds the National Institutes of Health also was approved by the House on June 29. Under the bill's provisions, NIH would receive a 4% budget increase, rather than the Administration's request for 5%, to $11.3 billion. Funding for the National Institute of General Medical Sciences, which provides the majority of NIH's funding for chemical research, would rise just 3% to $902 million, but funding for the National Center for Research Resources would increase 8% to $358 million. Included in that amount is $20 million, to be awarded competitively, for renovation and construction of extramural biomedical facilities.

Although NIH's increase probably wouldn't allow it to keep up with inflation, the agency fares better than the Department of Energy, whose House-approved budget would fall 7% to $11.8 billion. Funding for weapons R&D would be down 32% to $777 million. If the figures in the House bill hold up, fiscal 1995 would mark the first year DOE would spend more on cleaning up its messes from past activities—$5.9 billion—than it does on R&D.

The House has also approved a cut of 4% to $1.4 billion for the Department of Agriculture's research programs, and an increase of 45% to $1.1 billion for those at the Department of Commerce. □

New details on nuclear weapons program bared

In a continuing effort to be more candid about Department of Energy nuclear weapons programs, Energy Secretary Hazel R. O'Leary recently declassified a substantial amount of information. On June 27, she revealed details about total U.S. weapons-grade uranium production, testing of a bomb made of reactor-grade plutonium, radiation experiments conducted on humans since the 1920s, and underground and atmospheric nuclear weapons tests.

O'Leary explains the new revelations by saying thousands of people in meetings across the country this year have told her that "openness in government is very important. We are responding today in a manner that both satisfies the strong public interest and respects critical national security requirements."

The total U.S. production of highly enriched weapons-grade uranium is 994 metric tons, O'Leary says, far more than the 700 metric tons previously estimated by outside experts. Almost 259 metric tons remain in the U.S. stockpile, most of it stored at the DOE facility in Oak Ridge, Tenn. Most of the remaining 735 metric tons is contained in the weapons themselves. (Weapons-grade uranium is defined as at least 20% ^{235}U, with the remainder ^{238}U, but most of that produced for weapons is at least 90% ^{235}U.) It takes only about 25 kg of weapons-grade uranium to make a crude nuclear device.

DOE and the Department of Defense are now in the process of deciding how much of the weapons-grade uranium stockpile is surplus and what to do with it. Eventually, the surplus weapons uranium may be mixed with ^{238}U and used to fuel commercial nuclear power plants.

The testing of a bomb made of reactor-grade plutonium was known previously, but not the year, 1962, or the explosive power, less than 20 kilotons. Revelation of the test should convince people that plutonium extracted from spent commercial power plant fuel can be made into bombs. French, British, and Japanese nuclear power officials routinely assert that civilian plutonium has no strategic value. And the British government only recently said the 1962 test was "alleged to have been carried out" and refused to comment on it,

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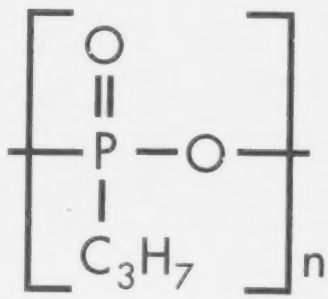

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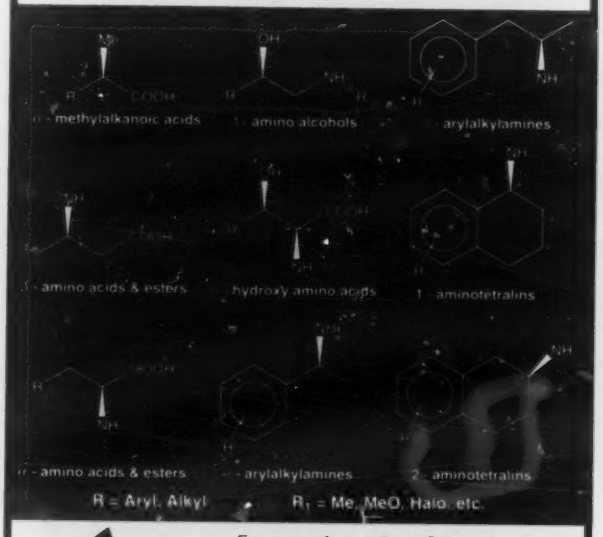

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even though it had supplied the plutonium for the test.

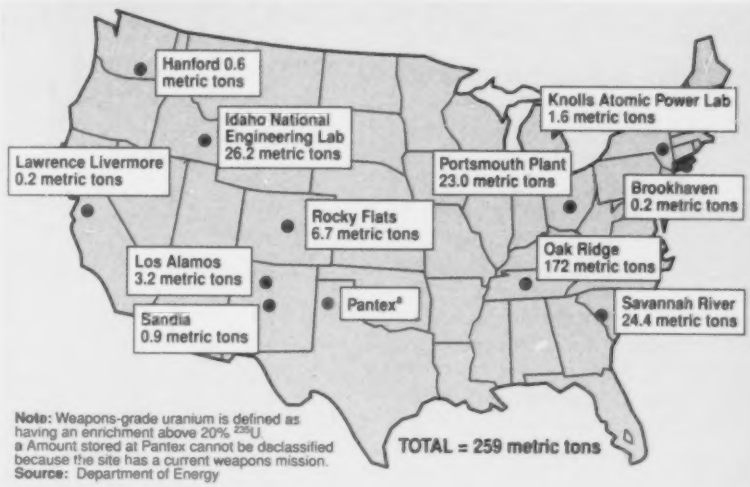
"Secretary Hazel O'Leary is to be congratulated for declassifying the important information that should lay to rest, once and for all, this dangerous misunderstanding," says Paul L. Levanthal, president of the Nuclear Control Institute (NCI) in Washington, D.C. NCI is a think tank to develop strategies for stopping the spread of nuclear arms.

O'Leary has not specified the size of the current U.S. nuclear weapons arsenal, but has disclosed its size in 1961—22,229 warheads. She also reveals that 17,187 weapons were dismantled between 1980 and the beginning of 1994.

In 1986, Rep. Edward J. Markey (D.-Mass.), then chairman of the House Energy & Commerce Subcommittee on Energy Conservation & Power, released a report giving details about experiments in which individuals were intentionally exposed to ionizing radiation.

O'Leary has released information about 48 additional tests not included in the Markey report. About half of these were secret until O'Leary's disclosure. The 48 tests involved as many as 1,200 people and were conducted at hospitals and universities across the country from the 1940s to the present. No medical benefit was expected from any of these tests, and for most, there is no record that the subjects were fully informed.

Substantial quantities of weapons-grade uranium are stored at 12 Department of Energy sites


Hanford 0.6 metric tons
Idaho National Engineering Lab 26.2 metric tons
Lawrence Livermore 0.2 metric tons
Knolls Atomic Power Lab 1.6 metric tons
Portsmouth Plant 23.0 metric tons
Brookhaven 0.2 metric tons
Rocky Flats 6.7 metric tons
Los Alamos 3.2 metric tons
Oak Ridge 172 metric tons
Pantex[a]
Savannah River 24.4 metric tons
Sandia 0.9 metric tons
TOTAL = 259 metric tons

Note: Weapons-grade uranium is defined as having an enrichment above 20% ^{235}U.
[a] Amount stored at Pantex cannot be declassified because the site has a current weapons mission.
Source: Department of Energy

In one test, healthy pregnant women were given tracer amounts of ^{59}Fe, ranging from 1.8 to 120 mg. A small increase in cancer incidence was found in their offspring—three cases in 634 exposed children compared with none in the controls.

DOE points out that this current list "represents only a small fraction of the total number of experiments that were conducted." It expects that more tests will be added to the list in the future by a Presidentially appointed advisory committee that is investigating this issue.

O'Leary also disclosed that the total number of nuclear weapons tests was 1,054, three more than announced previously. In addition, O'Leary revealed that 20 of the 828 underground tests conducted between 1961 and 1986 at the Nevada test site leaked radiation to the environment. The National Cancer Institute studied thyroid disease in populations exposed to the radiation from these tests and concluded in 1992 that thyroid cancer increased with exposure to ^{131}I radiation resulting from the tests.

Between 1946 and 1962, 67 atmospheric bomb tests were conducted in the Marshall Islands in the Pacific. O'Leary made public 460 previously classified records on these tests, including data on the 1954 test "Bravo" that had the explosive power of 1,000 Hiroshima-type atomic bombs and resulted in heavy contamination of several islands.

DOE is now indexing everything it has declassified since 1946 and putting it on Internet so it will be easily accessible.

Bette Hileman

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